Metadata form Revised 9/27/99

Data Used in the Clean Water Action Plan Unified Watershed Assessment

Name of Data Layer Forest Edge Density in Watershed

Definition (General Description) Length of forest edge in watershed, divided by land area of watershed.

Data Source MRLC land cover (v3); INRA watershed boundaries

Data Type: Condition __X__ Stressor ___ Vulnerability ____ Trend ____ Growth ____
Other ________________________________

Method of Calculation

Forest cover (deciduous forest, evergreen forest, mixed forest, and woody wetland) was calculated from MRLC v3. Primary, secondary, and county roads (e.g., roads considered large enough to break the canopy) were overlaid to determine patch boundaries. Differing land cover was also used to determine breaks in patch extent. Forest grid cells adjacent to non-forest or roads were identified using EUCDISTANCE, and summed for each INRA 8-digit watershed, using Summarize Zones in ArcView Spatial Analyst. The number of edge cells per watershed was multiplied by the cell edge width, an estimate that meant accuracy of >117 feet, but should have minimal effect on relative comparisons between watersheds. This was then divided by total land area of the watershed.

Watershed Scale: Tributary Strategy Region[1] ___ USGS 8-Digit ____ MD 6-Digit ____
MD 8-Digit _X_ MD 12-Digit ____ Adaptable to Any Scale ____Other __________________

Data Custodian MRLC (EPA Region III) Version 2 - USEPA; watershed summary table - DNR-Watershed Management and Analysis Division

Clean Water Goal: Yes __?__ No ____
If Yes: Description of Goal ____

Other Natural Resource Goal: Yes __?__ No ____
If Yes: Benchmark Goal ____ Relative Goal ____
Description of Goal - Protect forested ecosystem processes within watershed.

Assumptions Forest edge data is limited by MRLC format and resolution (30 meter pixels).

Comments Forested ecosystems provide water quality protection, aquifer recharge, soil protection and replenishment, CO_2 absorption, wildlife habitat, timber, hunting,

[1]The Youghiogeny watershed and the Coastal Bays region are considered to be Tributary Strategy Regions for the purposes of this program

fishing, and other recreational opportunities, and many other benefits. Watersheds did not include area outside Maryland. Edge metrics are discussed in Forman and Godron (1986) and McGarigal and Marks (1995). Also, see discussion below:

Landscape ecology and landscape disturbance

A "patch" can be defined as a contiguous part of the landscape, with comparable length and width, that is distinguished by discontinuities in its environmental characteristics from its surroundings (Wiens, 1976; White and Pickett, 1985; Forman and Godron, 1986). In wildlife ecology, these environmental differences are ones noticeable to animals (Wiens, 1976).

A patch edge is the outer band of the patch that is influenced by surrounding environmental conditions, and is thereby significantly different from the interior (Forman and Godron, 1986). Forest edges contain significant gradients of solar radiation, temperature, wind speed, and moisture between the forest patch interior and the adjacent land, especially if the adjacent land is developed (Forman and Godron, 1986; Brown et al, 1990). Increased solar radiation at the edge increases temperatures and decreases soil moisture and, with increased wind flow, decreases relative humidity (Forman and Godron, 1986; Brown et al, 1990). Increased wind speed at a newly created edge commonly knocks down trees that are no longer buffered by adjacent canopy and not structurally prepared (Brown et al, 1990). This poses a problem especially for wetland trees, which have shallow roots and less stable soil (Brown et al, 1990). Wind can also carry dust or other small particles, which can adhere to vegetation (Brown et al, 1990). Noise from developed land disrupts natural activity in adjacent forest or marsh, by drowning wildlife cues for territorial boundary establishment, courtship and mating behavior, detection of separated young, prey location, predator detection, and homing (Yahner, 1988; Brown et al, 1990). Sudden loud noises can also cause stress to animals (Brown et al, 1990). Clearcuts adjacent to forest can also cause excess runoff, erosion, nutrient loss, and loss of wildlife (Harris, 1984). They can also increase the chance of fire. For example, the weed-brush stage is the successional stage most subject to fire in Douglas fir forests (Harris, 1984).

Changes in insolation and other physical parameters at created edges change plant and animal communities there, and processes like nutrient cycling (Forman and Godron, 1986; Brown et al, 1990). Edge habitat differs from interior forest in tree species composition, primary production, structure, development, animal activity, and propagule dispersal capabilities (Brown et al, 1990; Kapos et al, 1993). The edge communities shift to more shade-intolerant, more xeric tree and shrub species, and early successional species (Brown et al, 1990). These then broadcast propagules that invade the forest interior (Brown et al, 1990). Opportunistic animals also often invade the interior from edges, and often prey on, outcompete, or parasitize interior species (Reese and Ratti, 1988; Robinson, 1988; Brown et al, 1990; Dunning et al, 1992). Increased nest predation may extend 300 to 600 meters inside the forest (Reese and Ratti, 1988; Yahner, 1988; Brown et al, 1990). Cowbirds parasitize bird nests up to 1000 feet from the forest edge (Reese and Ratti, 1988; Brown et al, 1990). Cats and dogs from developed areas can prey on or harass wildlife. Cats, which hunt on instinct, range large areas (30-228 ha); one cat studied with a regular diet of domestic food killed over 1600 mammals and 60 birds during an 18 month period (Brown et al, 1990).

Harris (1984) studied the fragmentation of old-growth forest in the Pacific Northwest. He found that as old-growth habitat patches became isolated from similar surrounding habitat, species with ranges beyond the patch were extirpated, and the number of species reduced. Isolation also decreases plant diversity, which further decreases animal diversity (Harris, 1984).

According to island biogeography theory (MacArthur and Wilson, 1967; Harris, 1984; Forman and Godron, 1986), species richness in landscape patches depends on patch area: $S = cA^z$; where S is the species diversity, A is the patch area, and c and z are constants. In the absence of compensating colonization, species become extinct in small patches faster than in larger patches (MacArthur and Wilson, 1967; Harris, 1984). Larger patches support a larger variety of habitats, are more likely to be noticed or stumbled on by colonists, support larger populations, which are less vulnerable to extinction, and support animals that require large home ranges (Brown et al, 1990).

The species most vulnerable to extinction in fragmented landscapes have small populations: large animals with large home ranges (i.e. top carnivores), ecological specialists, and species with variable populations that depend on patchy or unpredictable resources (Harris, 1984; Brown et al, 1990). The Baltimore County Department of Environmental Protection and Resource Management (1996) summarized studies of species types most affected by forest fragmentation. These include naturally rare species, wide-ranging species, nonvagile species, species with low fecundity, species dependent on patchy or unpredictable resources, species that are highly variable in population size, ground nesters, and interior forest species. For example, Gibbs (1998) found that low densities, fluctuating populations, high mobility, and specialized habitat needs make woodland amphibians vulnerable to local extinction caused by habitat fragmentation.

As patch size decreases, and as patches of habitat become more isolated, population sizes, especially of rare species, may decrease below the threshold needed to maintain genetic variance, withstand oscillations and meet social requirements like breeding and migration. The size needed to prevent adverse genetic drift is probably higher than the size needed to withstand oscillations (Harris, 1984). Inbreeding within small populations increases the chance that progeny will receive duplicate alleles from a common ancestor, which can lower the vigor and fecundity of species within a few generations, and limit adaptation to changing environmental conditions (Brown et al, 1990). The size needed to ensure genetic flexibility is even higher; this therefore determines the minimum population size (Harris, 1984; Vrijenhoek, 1985). Harris (1984) states that conservation should allow evolution of populations, species, and ecosystems, so they are more adaptive to change. Sufficient genetic variability is required for adaptive flexibility and future evolution; species should be conserved before their numbers drop low enough where they are endangered (Harris, 1984).

References

see references.wpd